PATENT ABSTRACTS OF JAPAN

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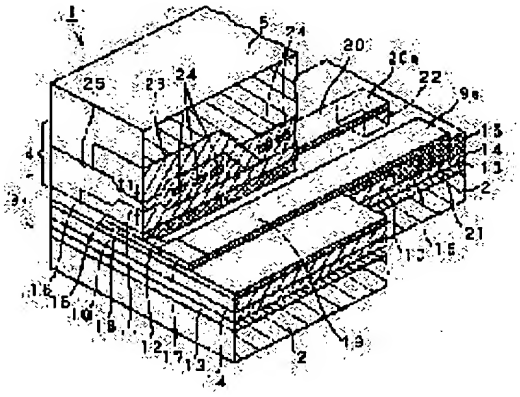
(54) MAGNETO RESISTIVE MAGNETIC HEAD

(57)Abstract:

PROBLEM TO BE SOLVED: To make an excessive current not to flow through an MR element by connecting a varistor to the MR element and making the current flow through the varistor in such a case that a high voltage is applied to the element.

SOLUTION: An MR element 12 is arranged between a lower layer shield 10 and an upper layer shield 11. An under coating layer 13 is made of a prescribed insulating material to achieve the insulation between a substrate 2 and a varistor 14. Then, the varistor 14 is formed on the under coating layer 13. The varistor 14 operates as a resistor whose resistance is nonlinearly decreased with the raising of an impressed voltage and is uniformly formed on the under coating layer 13 in a prescribed thickness. In this MR head 3, in such a case that a high voltage is impressed on the MR element 12 due to the flowing in of the electric charge from the outside or the like, the resistance value of the varistor 14 is decreased and the current is made to flow through the varistor 14. Thus, it is never generated that the excessive current is made to flow through the MR element 12.



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* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the magneto-resistive effect mold magnetic head which detects the field from a magnetic-recording medium by the magneto-resistive effect component.
[0002]
[Description of the Prior Art] In the magneto-resistive effect mold magnetic head (an MR head is called hereafter.) which detects the field from a magnetic-recording medium by the magneto-resistive effect component (MR component is called hereafter.), MR component will be destroyed by static electricity or a certain electrical stress, and that the head engine performance deteriorates poses a problem.
[0003] In addition, generally this problem is called ESD/EOS. ESD is the abbreviation for Electro Static Discharge, and EOS is the abbreviation for Electrical Over Stress.
[0004] And it is thought that such a problem is the effect of the magnetic field which an overcurrent flows for MR component and is generated according to generation of heat by this overcurrent or the overcurrent concerned, and is produced by destroying MR component.
[0005] That is, although produced through processes, such as a wafer process, a processing process, and an assembly process, when there is a charge inflow from the outside, in these processes, an overcurrent flows for MR component by the charge inflow concerned, and an MR head is the effect of the magnetic field generated according to generation of heat by this overcurrent, or the overcurrent concerned, and is considered that MR component is destroyed.
[0006] In addition, a wafer process is a process which forms the component which constitutes an MR head on a wafer substrate. Moreover, a processing process is a process which performs predetermined machining to those MR heads while it cuts the wafer substrate with which the component which constitutes an MR head was formed and divides it into each MR head. Moreover, an assembly process is a process which assembles the magnetic-head equipment with which the MR head which the above-mentioned machining completed was mounted on the head base, or the terminal of an MR head was connected to predetermined wiring, and the MR head was carried.
[0007] Moreover, destruction of MR component by ESD/EOS may be produced not only the inside of the above manufacture processes but after including an MR head in magnetic-head equipment. That is, for example, when an MR head is included in a hard disk drive unit, a charge flows into an MR head from a magnetic disk, and, thereby, there is a case so that an overcurrent may flow for MR component. And such an overcurrent is also set to one of the factors which cause destruction of MR component.
[0008] And as a measure for the above problems, the method of forming diode between one terminal of MR component and an other-end child is proposed conventionally, for example.
[0009]
[Problem(s) to be Solved by the Invention] However, since an advanced semi-conductor process is required for formation of diode, if it is going to avoid the above-mentioned problem by forming diode, a head manufacture process will become very complicated and the manufacturing cost of an MR head will increase sharply.
[0010] This invention is proposed in view of the above conventional actual condition, and it aims at making it destruction of MR component by ESD/EOS not arise in the MR head which detects the field from a magnetic-recording medium by MR component, without formation using a difficult component like diode.
[0011]
[Means for Solving the Problem] The MR head concerning this invention is characterized by having the varistor connected to MR component and the above-mentioned MR component for detecting the field from a magnetic-recording medium.

[0012] In this MR head, the varistor which is the resistor by which resistance decreases in nonlinear with the rise of applied voltage is connected to MR component. Therefore, when the high voltage joins MR component by the inflow of the charge from the outside etc., a current flows to a varistor side. An overcurrent seems therefore, not to flow for MR component in this MR head, even if there is an inflow of the charge from the outside etc.
[0013] In addition, as for MR component, in the above-mentioned MR head, it is desirable to be formed on the substrate with which the above-mentioned varistor was formed. Thus, when MR component is formed on the substrate with which the varistor was formed, the path which misses a current when there is an inflow of the charge from the outside will exist, before forming MR component. Therefore, in this MR head, the whole manufacture process of the MR head concerned can be covered, and destruction of MR component by ESD/EOS can be avoided.
[0014] In addition, in the above-mentioned MR head, one terminal is connected to MR component and, as for a varistor, an other-end child is grounded. Or one terminal of the varistor concerned is connected to one terminal of MR component, and, as for a varistor, the other-end child of the varistor concerned is connected to the other-end child of MR component, for example.
[0015] Moreover, as for a varistor, in the above-mentioned MR head, being formed using the sputtering method is desirable. Usually, MR component used for an MR head is formed using the sputtering method. Therefore, when a varistor is formed using the sputtering method, the period until it results [from formation of a varistor] in formation of MR component can be made into a series of sputtering processes. Therefore, simplification of a production process can be attained.
[0016]
[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained to a detail, referring to a drawing.
[0017] The 1st example of the magnetic head which applied <gestalt of the 1st operation> this invention is shown in drawing 1 . In addition, in drawing 1 , a part of magnetic head 1 is cut, and it is lacked and illustrated.
[0018] This magnetic head 1 is the magnetic head used for a hard disk drive unit etc., and while coming to form MR head 3 which applied this invention on the aluminum2O3-substrate 2 which consists of TiC etc., laminating formation of the inductive mold magnetic head 4 is carried out, and it comes to form the protective layer 5 which consists of aluminum2O3 grade on the inductive mold magnetic head 4 concerned further on MR head 3 concerned. Here, MR head 3 operates as a head for playback, and the inductive mold magnetic head 4 operates as a head for record.
[0019] MR head 3 is the so-called shielding type with which the MR component 12 was allotted between the lower layer shielding 10 and the upper shielding 11 of MR head. And the under coat layer 13 by which this MR head 3 was formed on the substrate 2, The varistor 14 formed on the under coat layer 13, and the lower layer shielding 10 formed on the varistor 14, It has the MR component 12 formed on the lower layer shielding 10 through the insulating layer 15 which consists of aluminum 2O3 or SiO2 grade, and the upper shielding 11 formed on the MR component 12 through the insulating layer 16 which consists of aluminum 2O3 or SiO2 grade.
[0020] The under coat layer 13 consists of an insulating material like aluminum2O3 grade, and the insulation with a substrate 2 and a varistor 14 is achieved by this under coat layer 13. And the varistor 14 is formed on this under coat layer 13.
[0021] A varistor 14 operates as a resistor by which resistance decreases in nonlinear with the rise of applied voltage, and it comes to form it in predetermined thickness on the under coat layer 13 uniformly. In this MR head 3, when the high voltage joins the MR component 12 by the charge inflow from the outside etc., the resistance of a varistor 14 decreases and a current flows to the varistor 14 concerned. An overcurrent seems therefore, not to flow for the MR component 12 in this MR head 3, even if there is a charge inflow from the outside etc.
[0022] Here, the varistor 14 is directly formed on the substrate 2 with which it comes to form the under coat layer 13. The varistor 14 is formed in the lowest layer of MR head 3 if it puts in another way. Thus, when a varistor 14 is formed in the lowest layer of MR head 3, the path which misses a current when there is an inflow of the charge from the outside will exist, before forming the MR component 12. Therefore, in this MR head 3, the whole manufacture process of MR head 3 concerned can be covered, and destruction of the MR component 12 by ESD/EOS can be avoided.
[0023] And the lower layer shielding 10 is formed on the varistor 14. The lower layer shielding 10 is for shielding the lower layer side of the MR component 12 magnetically, and consists of soft magnetism material, such as nickel-Fe. And the MR component 12 is formed through the insulating layer 15 on this lower layer shielding 10.
[0024] The MR component 12 is a component from which resistance changes with the magnitude of an external magnetic field, for example, it comes to carry out the laminating of Ta film, the NiFeNb film, Ta film, the NiFe film, and the Ta film to this order by the sputtering method. When the MR component 12 is considered as such a configuration, the NiFe film which is soft magnetism film which has a magneto-resistive effect serves as a magnetic

force sencor of MR head 3. Moreover, the NiFeNb film turns into soft magnetism film (the so-called Soft Adjacent Layer) for impressing a perpendicular bias field to the NiFe film. In addition, you may make it use MR component as shows the so-called giant magneto-resistance (GMR:Giant Magneto-Resistance effect) that what is necessary is not to restrict the configuration of the MR component 12 to the above-mentioned example, and just to use a suitable thing according to the demand of a system etc.

[0025] Moreover, the MR component 12 is made as [be / to a magnetic-recording medium opposed face / come to be formed in the shape of an abbreviation rectangle, and / exposed of the one side face]. And the permanent magnet film 17 and 18 for impressing a level bias field to the MR component 12 concerned is arranged on the both ends of this MR component 12, respectively.

[0026] The permanent magnet film 17 and 18 is for impressing a level bias field to the MR component 12, and attaining stabilization of actuation of the MR component 12 concerned. the ingredient of these permanent magnet film 17 and 18 -- carrying out -- hard magnetism material with large coercive force is desirable, and, specifically, CoNiPt, CoCrPt, etc. are suitable.

[0027] Moreover, the 1st conductor 19 is connected to the permanent magnet film 17 arranged so that the end of the MR component 12 might be touched, and the 2nd conductor 20 is connected to the permanent magnet film 18 similarly arranged so that the other end of the MR component 12 might be touched. To the MR component 12, these conductors 19 and 20 are for supplying a sense current, for example, consist of Cr, Ti, Ta, W, Mo, Cu(s), or these alloys.

[0028] Here, the near edge where the 1st conductor 19 is connected to the permanent magnet film 17 is formed so that it may lay under the insulating layers 15 and 16, but the other-end section is formed so that it may expose outside. And the part exposed outside is set to 1st terminal 19a for external connection of this MR head 3. It is formed so that similarly the edge of the side connected to the permanent magnet film 18 may also lay the 2nd conductor 20 under the insulating layers 15 and 16, but the other-end section is formed so that it may expose outside. And the part exposed outside is set to 2nd terminal 20a for external connection of this MR head 3. And a sense current will be supplied to the MR component 12 from these terminals 19a and 20a for external connection at the time of playback of the magnetic signal from a magnetic-recording medium.

[0029] Moreover, opening 21 is formed in the part located under 1st terminal 19a for external connection among the insulating layers 15 concerned although the insulating layer 15 is formed in the lower layer of the 1st conductor 19. And the 1st conductor 19 is connected to the varistor 14 through the opening 21 concerned. Similarly, opening 22 is formed in the part located under 2nd terminal 20a for external connection among the insulating layers 15 concerned although the insulating layer 15 is formed in the lower layer of the 2nd conductor 20. And the 2nd conductor 20 is connected to the varistor 14 through the opening 22 concerned. If it puts in another way, in this MR head 3, one terminal of the varistor 14 concerned is connected to one terminal of the MR component 12, and, as for the varistor 14, the other-end child of the varistor 14 concerned is connected to the other-end child of the MR component 12.

[0030] And the insulating layer 16 is formed on the MR component 12 formed as mentioned above, the permanent magnet film 17 and 18, the 1st conductor 19, and the 2nd conductor 20, and the upper shielding 11 is formed on the insulating layer 16 concerned. In addition, an insulating layer 16 and the upper shielding 11 are formed so that it is outside exposed of the end of the 1st conductor 19, and it is set to 1st terminal 19a for external connection, and it may be outside exposed of the end of the 2nd conductor 20 and it may be set to 2nd terminal 20a for external connection.

[0031] The upper shielding 11 is for shielding the upper layer side of the MR component 12 magnetically, and consists of soft magnetism material, such as nickel-Fe. In addition, this upper shielding 11 not only shields the upper layer side of the MR component 12 magnetically, but serves as the magnetic core of the inductive mold magnetic head 4 by which laminating formation was carried out on MR head 3 so that it may mention later.

[0032] MR head 12 has the above configurations and laminating formation of the inductive mold magnetic head 4 which is a head for record is carried out on this MR head 3.

[0033] This inductive mold magnetic head 4 is equipped with the magnetic core constituted by the upper shielding 11 and the upper core 23 and the thin film coil 24 formed so that the magnetic core concerned might be wound.

[0034] The upper core 23 forms a closed magnetic circuit with the upper shielding 11, turns into a magnetic core of the inductive mold magnetic head 4, and consists of soft magnetism material, such as nickel-Fe. Here, the upper shielding 11 and the upper core 23 are formed so that it may be exposed of the front end section of them to a magnetic-recording medium opposed face and the upper shielding 11 and the upper core 23 may touch mutually in the back end section of them. Here, in the magnetic-recording medium opposed face, the front end section of the upper shielding 11 and the upper core 23 is formed so that the upper shielding 11 and the upper core 23 may estrange with the predetermined gap t1.

[0035] In this magnetic head 1, the magnetic core of the inductive mold magnetic head 4 serves the upper shielding 11

not only shields the upper layer side of the MR component 12 magnetically, but, and the magnetic core of the inductive mold magnetic head 4 is constituted by the upper shielding 11 and the upper core 23. And the gap t1 of the upper shielding 11 and the upper core 23 in a magnetic-recording medium opposed face serves as a magnetic gap for record of the inductive mold magnetic head 4.

[0036] Moreover, on the upper shielding 11, the insulating layer 25 which consists of aluminum 2O3 or SiO2 grade is formed, and the thin film coil 24 is laid under this insulating layer 25. Here, the thin film coil 24 is formed so that the magnetic core which consists of the upper shielding 11 and the upper core 23 may be wound. In addition, although not illustrated, the both ends of this thin film coil 24 are made as [expose / outside]. And the terminal formed in the both ends of the thin film coil 24 turns into a terminal for external connection of this inductive mold magnetic head 4. That is, a record current will be supplied to the thin film coil 24 from these terminals for external connection at the time of record of the magnetic signal to a magnetic-recording medium.

[0037] In the magnetic head 1 which has the above configurations As a path of a current of flowing between 1st terminal 19a for external connection of MR head 3, and 2nd terminal 20a for external connection The 1st path which connects 1st terminal 19for external connection a, the 1st conductor 19, the permanent magnet film 17, the MR component 12, the permanent magnet film 18, the 2nd conductor 20, and 2nd terminal 20a for external connection, It has the 2nd path which connects 1st terminal 19for external connection a, a varistor 14, and 2nd terminal 20a for external connection.

[0038] That is, in this MR head 3, as shown in drawing 2 , the varistor 14 is connected to juxtaposition to the MR component 12. Here, a varistor 14 operates as a resistor by which resistance decreases in nonlinear with the rise of applied voltage. Therefore, when the high voltage joins the MR component 12 by the inflow of the charge from the outside etc., a current flows to a varistor 14 side. An overcurrent seems therefore, not to flow for the MR component 12 in this MR head 3, even if there is an inflow of the charge from the outside etc.

[0039] And in this MR head 3, as shown in drawing 1 , the varistor 14 is formed on the substrate 2 which the under coat layer 13 is formed and becomes, and the MR component 12 is formed, after forming a varistor 14. Thus, when the MR component 12 is formed after forming a varistor 14, the path which misses a current when there is an inflow of the charge from the outside will exist, before forming the MR component 12. Therefore, in this MR head 3, the whole manufacture process of MR head 3 concerned can be covered, and destruction of the MR component 12 by ESD/EOS can be avoided.

[0040] In addition, although an electrical potential difference is impressed so that a sense current may flow for the MR component 12 in case a magnetic signal is reproduced from a magnetic-recording medium, the electrical potential difference concerned has the farther [than the critical voltage which becomes low rapidly] small resistance of a varistor 14. Therefore, even if the varistor 14 is connected to juxtaposition to the MR component 12, a sense current will hardly flow to a varistor 14 side always [forward], but will flow to the MR component 12 side.

[0041] Although various kinds of varistors, such as a ZnO system varistor, a SiC system varistor, and a SrTiO3 system varistor, are usable as such a varistor 14, if a speed of response etc. is taken into consideration, as a varistor 14 used in this example, a ZnO system varistor is suitable. Moreover, the so-called ZnO-Bi2O3 system varistor which added Bi 2O3 of a minute amount also especially in the ZnO system varistor is suitable.

[0042] First, in case a ZnO-Bi2O3 system varistor is used as a varistor 14, while adding Bi 2O3 of a minute amount to the impalpable powder of Zn-O, according to the property for which it asks, CoO, MnO2, Cr 2O3, Sb2O3, SiO2, and TiO2 grade are added to it, and a varistor raw material is obtained to it. And the obtained varistor raw material is applied on the substrate 2 with which the under coat layer 13 was formed, and is calcinated at the temperature of about 1100-1200 degrees C in air after that. By this, the varistor 14 of 2OZnO-Bi3 system will be formed on the under coat layer 13.

[0043] In addition, in case a varistor 14 is formed, it does not form by the above calcinating methods, but you may make it form by the sputtering method. What is necessary is to carry out a sputtering target and just to use the target which consists of a configuration element of a varistor 14, in case a varistor 14 is formed by the sputtering method.

[0044] Moreover, when a varistor 14 is formed by the sputtering method, it is desirable to also perform membrane formation of the layer (the lower layer shielding 10, the upper shielding 11, the MR component 12, insulating layers 15 and 16, the permanent magnet film 17 and 18, conductors 19 and 20) of others which constitute above-mentioned MR head 3 by the sputtering method. In this case, since a process until it results [from formation of a varistor 14] in formation of other each class turns into a series of sputtering processes, a production process can be simplified compared with a case so that a varistor 14 may be formed by the calcinating method.

[0045] The 2nd example of the magnetic head which applied <gestalt of the 2nd operation> this invention is shown in drawing 3 . In addition, in drawing 3 , a part of magnetic head 101 is cut, and it is lacked and illustrated.

[0046] This magnetic head 101 is the magnetic head used for a hard disk drive unit etc., and while coming to form MR head 103 which applied this invention on the aluminum2O3-substrate 102 which consists of electric conduction material, such as TiC, laminating formation of the inductive mold magnetic head 104 is carried out, and it comes to form the protective layer 105 which consists of aluminum2O3 grade on the inductive mold magnetic head 104 concerned further on MR head 103 concerned. Here, MR head 103 operates as a head for playback, and the inductive mold magnetic head 104 operates as a head for record.
[0047] MR head 103 is the so-called shielding type with which the MR component 112 was allotted between the lower layer shielding 110 and the upper shielding 111 of MR head. And the varistor 114 by which this MR head 103 was formed on the substrate 102, The under coat layer 113 formed on the varistor 114, and the lower layer shielding 110 formed on the under coat layer 113, It has the MR component 112 formed on the lower layer shielding 110 through the insulating layer 115 which consists of aluminum 2O3 or SiO2 grade, and the upper shielding 111 formed on the MR component 112 through the insulating layer 116 which consists of aluminum 2O3 or SiO2 grade.
[0048] A varistor 114 operates as a resistor by which resistance decreases in nonlinear with the rise of applied voltage, and it comes to form it in predetermined thickness on a substrate 102 uniformly. In this MR head 103, when the high voltage joins the MR component 112 by the charge inflow from the outside etc., the resistance of a varistor 114 decreases and a current flows to the varistor 114 concerned. An overcurrent seems therefore, not to flow for the MR component 112 in this MR head 103, even if there is a charge inflow from the outside etc.
[0049] Here, the varistor 114 is directly formed on the substrate 102. The varistor 114 is formed in the lowest layer of MR head 103 if it puts in another way. Thus, when a varistor 114 is formed in the lowest layer of MR head 103, the path which misses a current when there is an inflow of the charge from the outside will exist, before forming the MR component 112. Therefore, in this MR head 103, the whole manufacture process of MR head 103 concerned can be covered, and destruction of the MR component 112 by ESD/EOS can be avoided.
[0050] And the under coat layer 113 is formed on the varistor 114. The under coat layer 113 consists of an insulating material like aluminum2O3 grade, and the lower layer shielding 110 is formed on this under coat layer 113. That is, the insulation with a varistor 114 and the lower layer shielding 110 is achieved by this under coat layer 113.
[0051] The lower layer shielding 110 formed on the under coat layer 113 is for shielding the lower layer side of the MR component 112 magnetically, and consists of soft magnetism material, such as nickel-Fe. And the MR component 112 is formed through the insulating layer 115 on this lower layer shielding 110.
[0052] The MR component 112 is a component from which resistance changes with the magnitude of an external magnetic field, for example, it comes to carry out the laminating of Ta film, the NiFeNb film, Ta film, the NiFe film, and the Ta film to this order by the sputtering method. When the MR component 112 is considered as such a configuration, the NiFe film which is soft magnetism film which has a magneto-resistive effect serves as a magnetic force sencor of MR head 103. Moreover, the NiFeNb film turns into soft magnetism film (the so-called Soft Adjacent Layer) for impressing a perpendicular bias field to the NiFe film. In addition, you may make it use MR component as shows giant magneto-resistance that what is necessary is not to restrict the configuration of the MR component 112 to the above-mentioned example, and just to use a suitable thing according to the demand of a system etc.
[0053] Moreover, the MR component 112 is made as [be / to a magnetic-recording medium opposed face / come to be formed in the shape of an abbreviation rectangle, and / exposed of the one side face]. And the permanent magnet film 117,118 for impressing a level bias field to the MR component 112 concerned is arranged on the both ends of this MR component 112, respectively.
[0054] The permanent magnet film 117,118 is for impressing a level bias field to the MR component 112, and attaining stabilization of actuation of the MR component 112 concerned. the ingredient of this permanent magnet film 117,118 -- carrying out -- hard magnetism material with large coercive force is desirable, and, specifically, CoNiPt, CoCrPt, etc. are suitable.
[0055] Moreover, the 1st conductor 119 is connected to the permanent magnet film 117 arranged so that the end of the MR component 112 might be touched, and the 2nd conductor 120 is connected to the permanent magnet film 118 similarly arranged so that the other end of the MR component 112 might be touched. To the MR component 112, these conductors 119,120 are for supplying a sense current, for example, consist of Cr, Ti, Ta, W, Mo, Cu(s), or these alloys.
[0056] Here, the near edge where the 1st conductor 119 is connected to the permanent magnet film 117 is formed so that it may lay under the insulating layer 115,116, but the other-end section is formed so that it may expose outside. And the part exposed outside is set to 1st terminal 119a for external connection of this MR head 103. It is formed so that similarly the edge of the side connected to the permanent magnet film 118 may also lay the 2nd conductor 120 under the insulating layer 115,116, but the other-end section is formed so that it may expose outside. And the part exposed outside is set to 2nd terminal 120a for external connection of this MR head 103. And a sense current will be

supplied to the MR component 112 from these terminals 119a and 120a for external connection at the time of playback of the magnetic signal from a magnetic-recording medium.

[0057] Moreover, opening 121 is formed in the part located under 1st terminal 119a for external connection among an insulating layer 115 and the under coat layer 113 although the insulating layer 115 and the under coat layer 113 are formed in the lower layer of the 1st conductor 119. And the 1st conductor 119 is connected to the varistor 114 through the opening 121 concerned. That is, one terminal of a varistor 114 is connected to MR component in this MR head 103. In addition, the 2nd conductor 120 is not connected to a varistor 114 in this MR head 103.

[0058] By the way, in this magnetic head 101, since the varistor 114 is directly formed on the substrate 112, a substrate 112 serves as an other-end child of a varistor 114. And a substrate 112 is connected to touch-down potential among the manufacture process of this magnetic head 101. Moreover, a substrate 112 is connected to touch-down potential also when this magnetic head 101 is included in magnetic-head equipment. Therefore, one terminal will be connected to the 1st conductor 119 as mentioned above, and an other-end child will be grounded for a varistor 114.

[0059] And the insulating layer 116 is formed on the MR component 112 formed as mentioned above, the permanent magnet film 117,118, the 1st conductor 119, and the 2nd conductor 120, and the upper shielding 111 is formed on the insulating layer 116 concerned. In addition, an insulating layer 116 and the upper shielding 111 are formed so that it is outside exposed of the end of the 1st conductor 119, and it is set to 1st terminal 119a for external connection, and it may be outside exposed of the end of the 2nd conductor 120 and it may be set to 2nd terminal 120a for external connection.

[0060] The upper shielding 111 is for shielding the upper layer side of the MR component 112 magnetically, and consists of soft magnetism material, such as nickel-Fe. In addition, this upper shielding 111 not only shields the upper layer side of the MR component 112 magnetically, but serves as the magnetic core of the inductive mold magnetic head 104 by which laminating formation was carried out on MR head 103 so that it may mention later.

[0061] MR head 112 has the above configurations and laminating formation of the inductive mold magnetic head 4 which is a head for record is carried out on this MR head 103.

[0062] This inductive mold magnetic head 104 is equipped with the magnetic core constituted by the upper shielding 111 and the upper core 123 and the thin film coil 124 formed so that the magnetic core concerned might be wound.

[0063] The upper core 123 forms a closed magnetic circuit with the upper shielding 111, turns into a magnetic core of the inductive mold magnetic head 104, and consists of soft magnetism material, such as nickel-Fe. Here, the upper shielding 111 and the upper core 123 are formed so that it may be exposed of the front end section of them to a magnetic-recording medium opposed face and the upper shielding 111 and the upper core 123 may touch mutually in the back end section of them. Here, in the magnetic-recording medium opposed face, the front end section of the upper shielding 111 and the upper core 123 is formed so that the upper shielding 111 and the upper core 123 may estrange with the predetermined gap t2.

[0064] In this magnetic head 101, the magnetic core of the inductive mold magnetic head 104 serves the upper shielding 111 not only shields the upper layer side of the MR component 112 magnetically, but, and the magnetic core of the inductive mold magnetic head 104 is constituted by the upper shielding 111 and the upper core 123. And the gap t2 of the upper shielding 111 and the upper core 123 in a magnetic-recording medium opposed face serves as a magnetic gap for record of the inductive mold magnetic head 104.

[0065] Moreover, on the upper shielding 111, the insulating layer 125 which consists of aluminum 2O3 or SiO2 grade is formed, and the thin film coil 124 is laid under this insulating layer 125. Here, the thin film coil 124 is formed so that the magnetic core which consists of the upper shielding 111 and the upper core 123 may be wound. In addition, although not illustrated, the both ends of this thin film coil 124 are made as [expose / outside]. And the terminal formed in the both ends of the thin film coil 124 turns into a terminal for external connection of this inductive mold magnetic head 104. That is, a record current will be supplied to the thin film coil 24 from these terminals for external connection at the time of record of the magnetic signal to a magnetic-recording medium.

[0066] In the magnetic head 101 which has the above configurations As a path of a current of flowing between 1st terminal 119a for external connection of MR head 103, and 2nd terminal 120a for external connection The 1st path which connects 1st terminal 119for external connection a, the 1st conductor 119, the permanent magnet film 117, the MR component 112, the permanent magnet film 118, the 2nd conductor 120, and 2nd terminal 120a for external connection, It has the 2nd path which results in the substrate 102 connected to touch-down potential from 1st terminal 119for external connection a through the varistor 114.

[0067] That is, in this MR head 103, as shown in drawing 4 , the end of the MR component 112 is grounded through the varistor 114. Here, a varistor 114 operates as a resistor by which resistance decreases in nonlinear with the rise of applied voltage. Therefore, when the high voltage joins the MR component 112 by the inflow of the charge from the

outside etc., a current flows to a varistor 114 side. An overcurrent seems therefore, not to flow for the MR component 112 in this MR head 103, even if there is an inflow of the charge from the outside etc.
[0068] And in this MR head 103, as shown in drawing 3 , the varistor 114 is formed on the substrate 102, and the MR component 112 is formed, after forming a varistor 114. Thus, when the MR component 112 is formed after forming a varistor 114, the path which misses a current when there is an inflow of the charge from the outside will exist, before forming the MR component 112. Therefore, in this MR head 103, the whole manufacture process of MR head 103 concerned can be covered, and destruction of the MR component 112 by ESD/EOS can be avoided.
[0069] In addition, although an electrical potential difference is impressed so that a sense current may flow for the MR component 112 in case a magnetic signal is reproduced from a magnetic-recording medium, the electrical potential difference concerned has the farther [than the critical voltage which becomes low rapidly] small resistance of a varistor 114. Therefore, even if the varistor 114 is connected to the MR component 112, a sense current will hardly flow to a varistor 114 side always [forward], but will flow to the MR component 112 side.
[0070] Although various kinds of varistors, such as a ZnO system varistor, a SiC system varistor, and a SrTiO3 system varistor, are usable as such a varistor 114, if a speed of response etc. is taken into consideration, as a varistor 114 used in this example, a ZnO system varistor is suitable. Moreover, the so-called ZnO-Bi2O3 system varistor which added Bi 2O3 of a minute amount also especially in the ZnO system varistor is suitable.
[0071] First, in case a ZnO-Bi2O3 system varistor is used as a varistor 114, while adding Bi 2O3 of a minute amount to the impalpable powder of Zn-O, according to the property for which it asks, CoO, MnO2, Cr 2O3, Sb2O3, SiO2, and TiO2 grade are added to it, and a varistor raw material is obtained to it. And the obtained varistor raw material is applied on a substrate 102, and is calcinated at the temperature of about 1100-1200 degrees C in air after that. By this, the varistor 114 of 2OZnO-Bi3 system will be formed on a substrate 102.
[0072] In addition, in case a varistor 114 is formed, it does not form by the above calcinating methods, but you may make it form by the sputtering method. What is necessary is to carry out a sputtering target and just to use the target which consists of a configuration element of a varistor 114, in case a varistor 114 is formed by the sputtering method.
[0073] Moreover, when a varistor 114 is formed by the sputtering method, it is desirable to also perform membrane formation of the layer (the lower layer shielding 110, the upper shielding 111, the MR component 112, an insulating layer 115,116, the permanent magnet film 117,118, conductor 119,120) of others which constitute above-mentioned MR head 103 by the sputtering method. In this case, since a process until it results [from formation of a varistor 114] in formation of other each class turns into a series of sputtering processes, a production process can be simplified compared with a case so that a varistor 114 may be formed by the calcinating method.
[0074]
[Effect of the Invention] When the varistor is connected to MR component and the high voltage joins MR component by the inflow of the charge from the outside etc., he is trying for a current to flow to a varistor side in the MR head concerning this invention, as explained to the detail above. An overcurrent seems therefore, not to flow for MR component in the MR head concerning this invention, even if there is an inflow of the charge from the outside etc. Therefore, in the MR head concerning this invention, it is hard to produce destruction of MR component by ESD/EOS.
[0075] A production process seems and not to complicate in the MR head concerning this invention, since not a component with difficult formation but the varistor with easy manufacture is used like diode. Therefore, according to this invention, even if it takes the measures to destruction of MR component by ESD/EOS, the rise of the manufacturing cost of an MR head can be suppressed.

[Translation done.]